



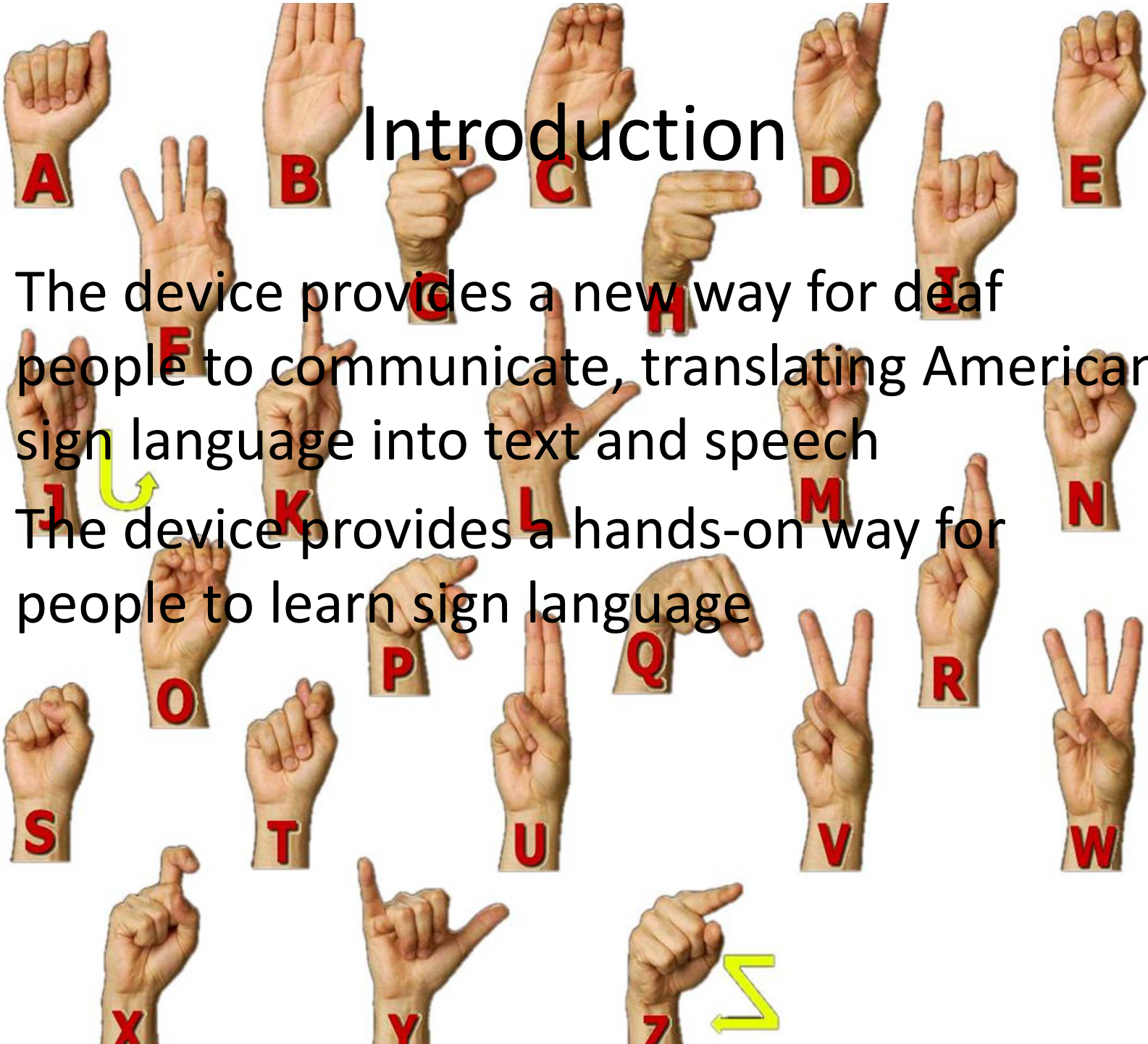
SD1102: Hand – 2 – Speech

Mohammed Albalawi, Davis Beattie,
Stephen Farnsworth

Advisor: Dr. Ababei

Introduction

- The device provides a new way for deaf people to communicate, translating American sign language into text and speech
- The device provides a hands-on way for people to learn sign language



Requirements

- The device must use sensors to detect the motions of the hand
 - Flex Sensors and Accelerometer
- The device must be wireless, sending from a module on the glove to a receiver
 - Xbee Modules
- The receiver must interface with a PC using USB.

Requirements

- The device must recognize words and phrases and “say” them using speech
 - Recognizes the American Sign Language alphabet
 - Speech element may come from previous program
 - Google Translate
- The glove must be battery powered and the module must be compact enough to fit on a hand.
- The group must design and order the PCBs (no premade wireless networks/PCBs)
- The group wiki page must be updated periodically citing major progress

Hardware Design

- Flex Sensors and Accelerometers
- Power Regulation
- USB Device
- Printed Circuit Board Design
 - Multisim
 - USB Schematic
 - Glove Schematic
 - Ultiboard
 - USB Schematic
 - Glove Schematic

Flex Sensors and Accelerometers

- Flex Sensors

- Ideal

- All Flex sensors same resistive range

- Actual

- Many different resistive values
 - Durability

- Accelerometer

- Use for hand position

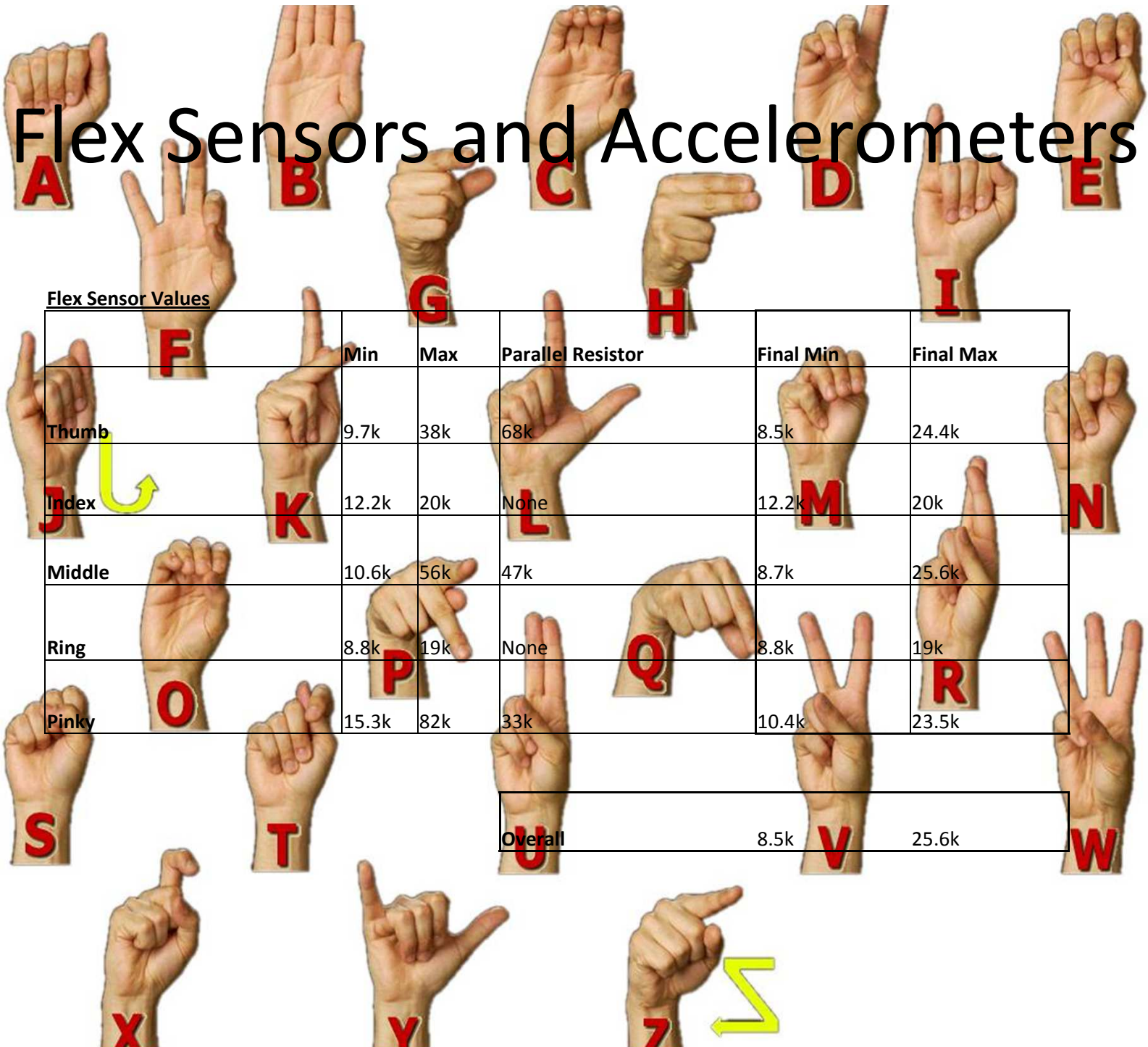
- For letters that are similar to one another



Flex Sensors and Accelerometers

- Use a voltage dividers to read the resistance values of flex sensors
- Use non-inverting amplifier utilize for range of analog to digital conversion
 - 0-5V Ideally
- A multiplexor is used to allow only one op amp to be used with all flex sensors

Flex Sensors and Accelerometers



Flex Sensors and Accelerometer

- Voltage Divider with Non-Inverting Amplifier

$$3.3V = 5V \times \frac{8k}{R + 8k}$$

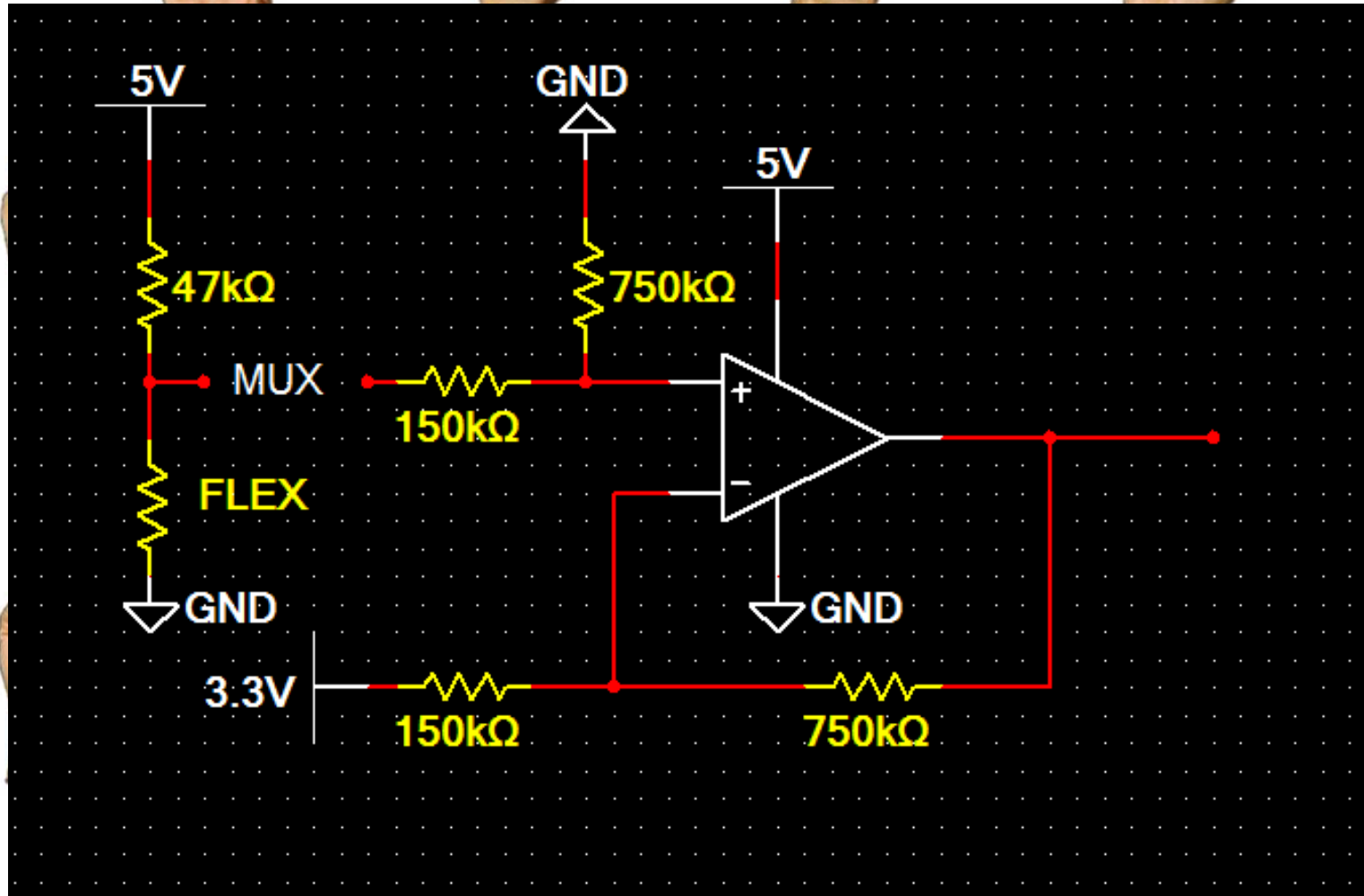
- $R = 4.1k$, so a $3.9k$ resistor is used

- Amplifier Gain

$$Gain = \frac{5}{4.35 - 3.36} = 5.05$$

- So $R1 = 750k$ and $R2 = 150k$, with $3.3V$ offset

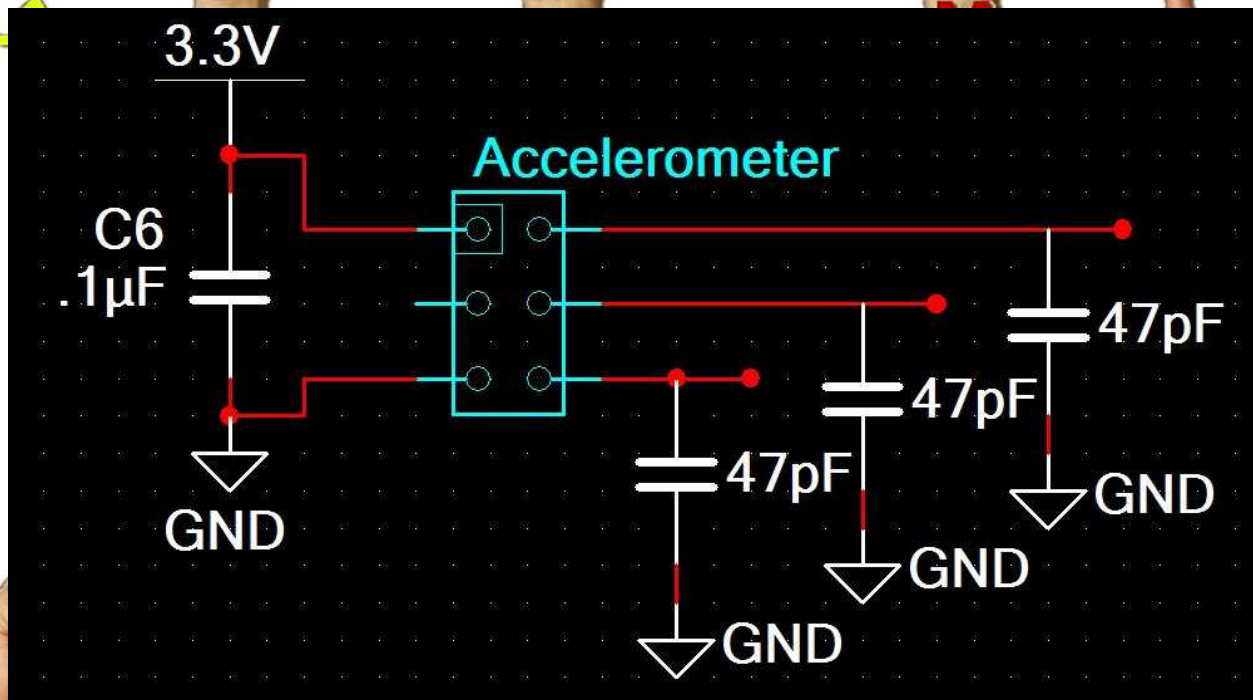
Flex Sensors and Accelerometer



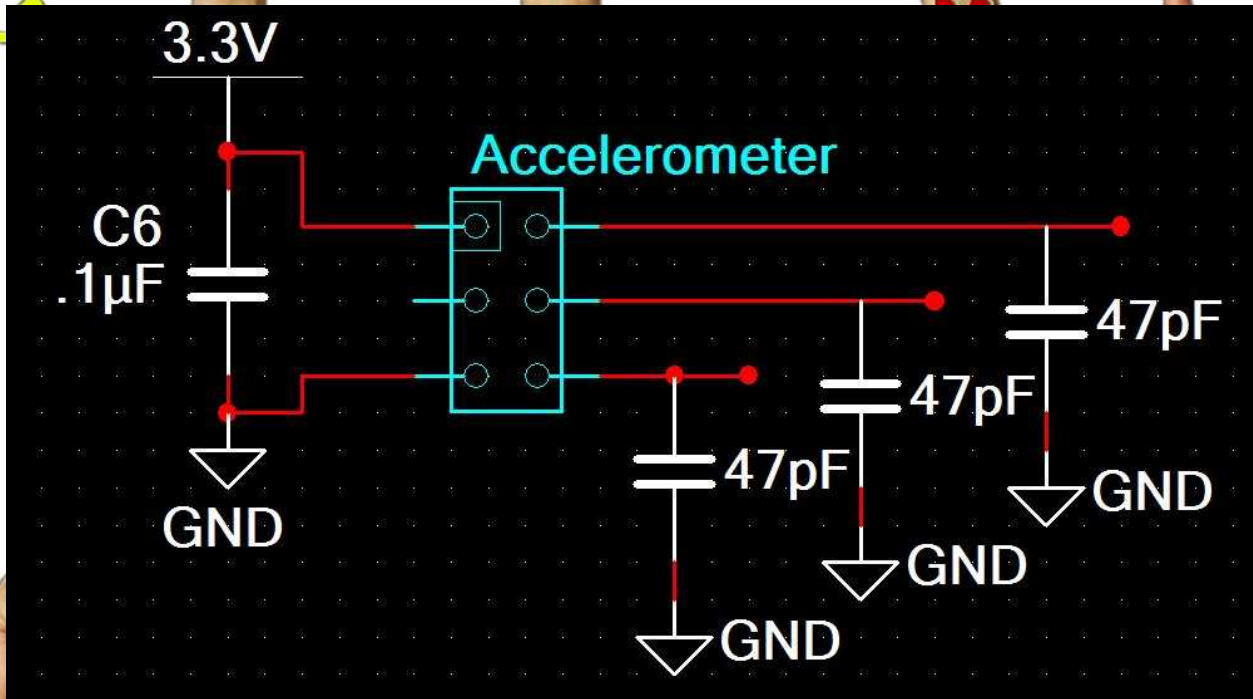
Flex Sensors and Accelerometer

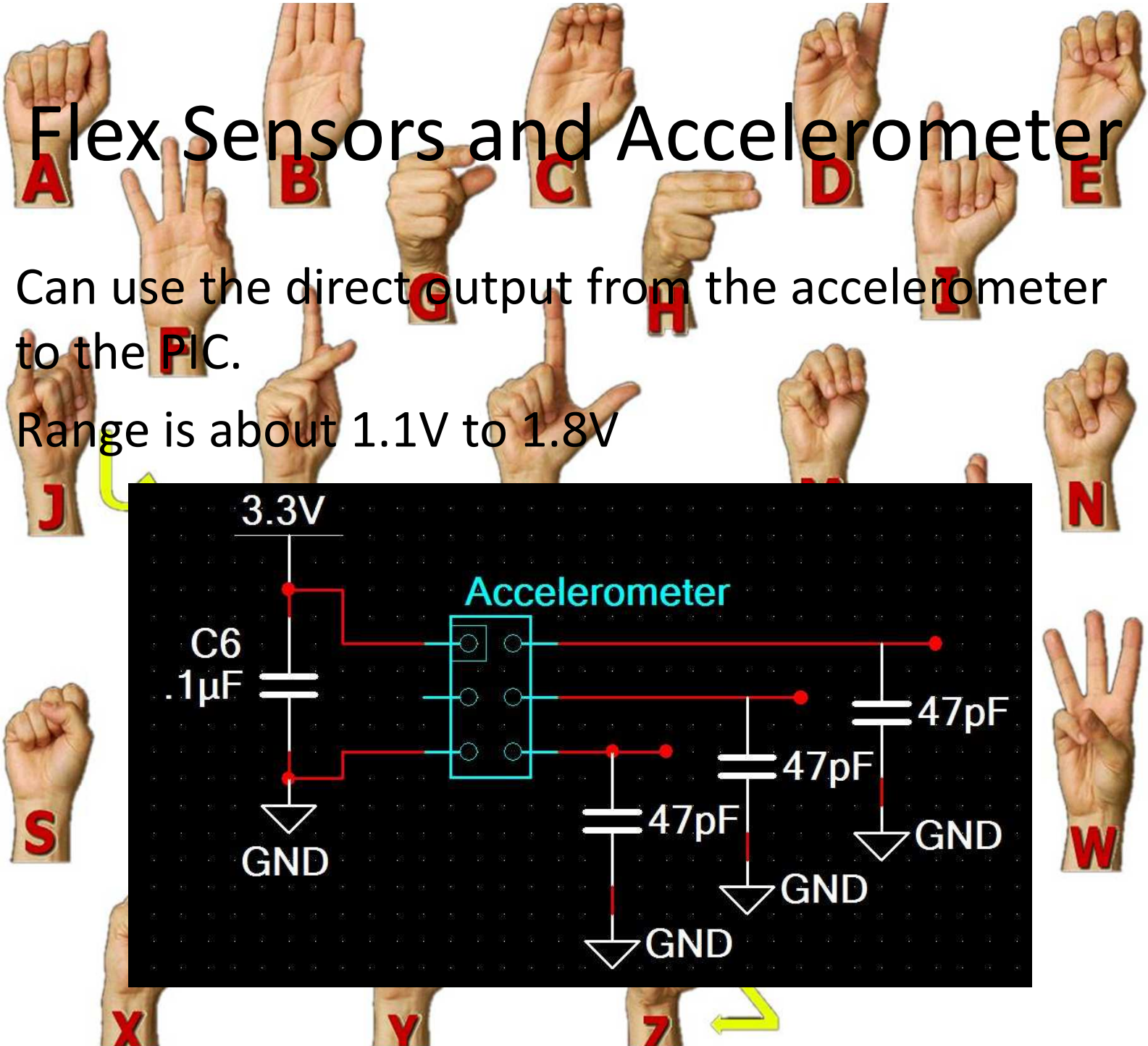
Can use the direct output from the accelerometer to the PIC.

Range is about 1.1V to 1.8V

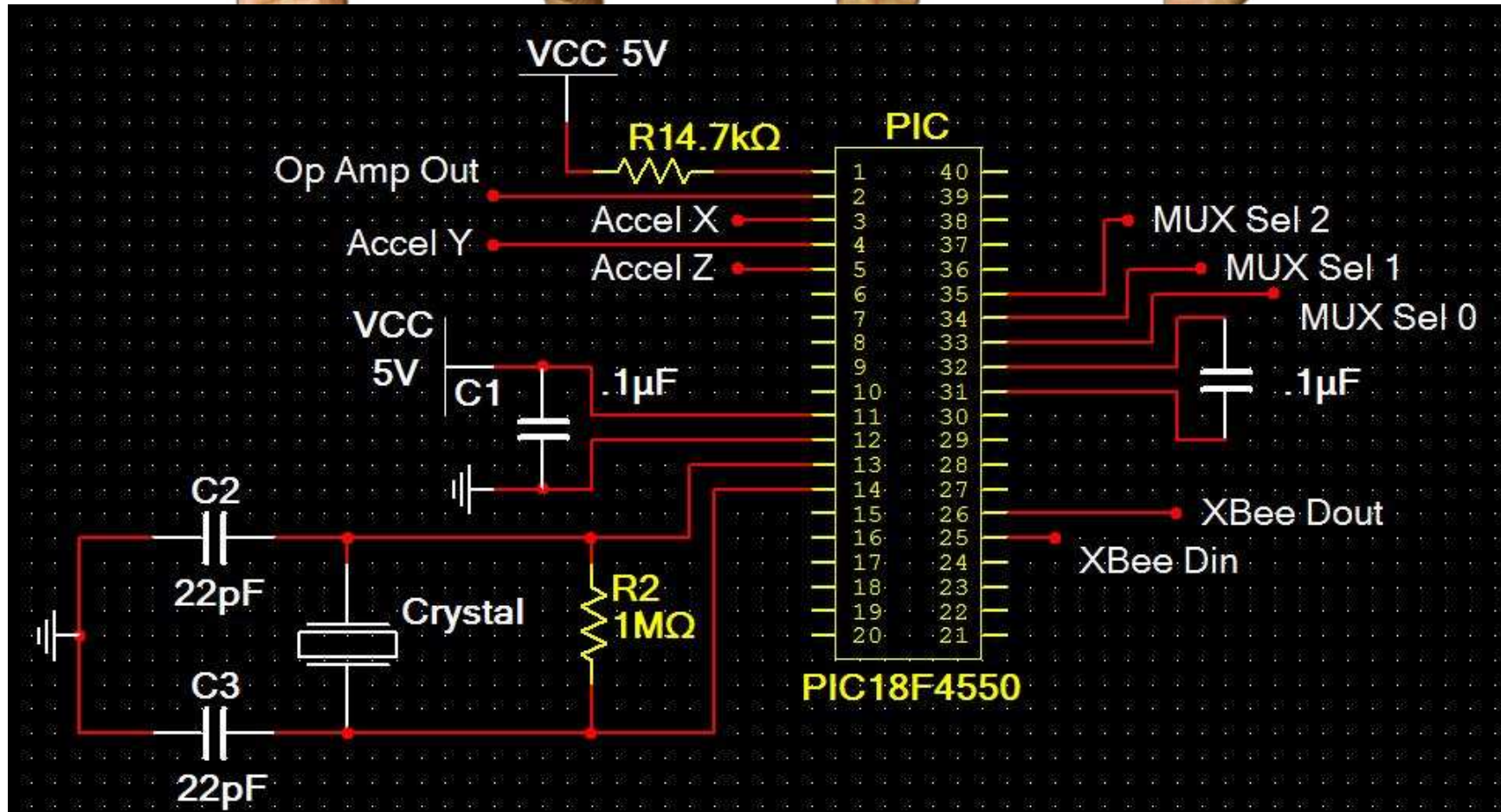


The diagram shows a circuit for an accelerometer module. A 3.3V supply is connected to the module. A capacitor C6, labeled .1μF, is connected between the 3.3V supply and ground. The accelerometer module is connected to ground through four 47pF capacitors. The output of the accelerometer is connected to a PIC (not shown).

- # Flex Sensors and Accelerometer
- Can use the direct output from the accelerometer to the PIC.
- Range is about 1.1V to 1.8V
- 
- The diagram shows a circuit for an accelerometer module. A 3.3V supply is connected to the VCC pin of the accelerometer. A 0.1μF capacitor (C6) is connected between the 3.3V supply and ground. The accelerometer module is connected to ground through four 47pF capacitors. The output of the accelerometer is connected to a PIC microcontroller.



Flex Sensor PIC



X

Y

Z

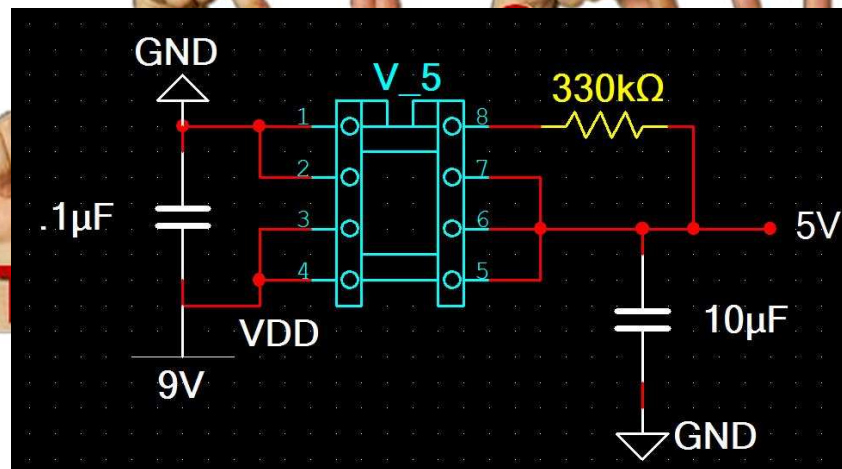
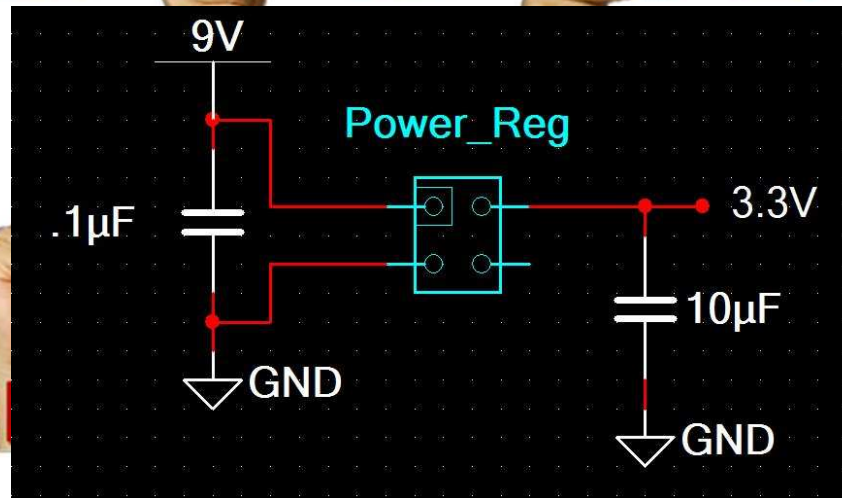


Power Regulation

- Use a 9V battery to power both 5V power regulator and 3.3V power regulator

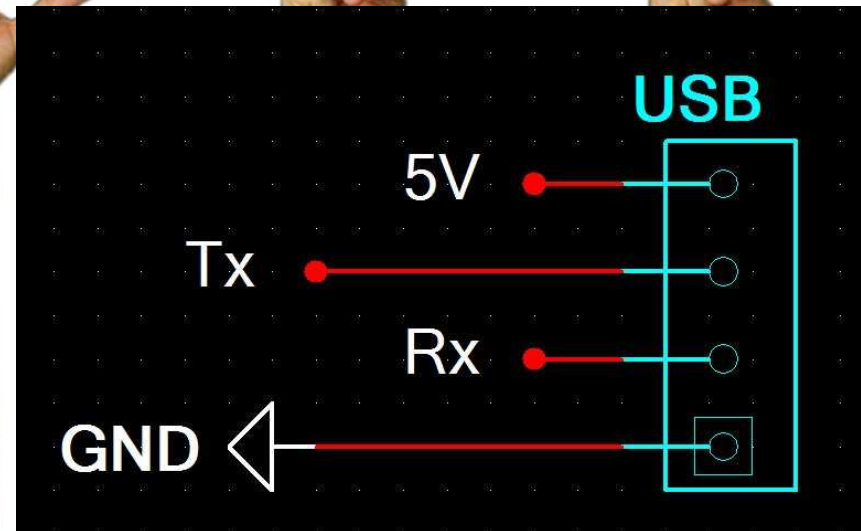
System Current Draw			
		Input	Output
TPS7150Y 5V Regulator		285μA	500mA
PIC18F4550		25mA	
SN74HC481 MUX		2μA	
MCP602 Op Amp		230μA	
Xbee RF Module		45mA	
5V to Flex Sensor (5)		20μA	
LP2950 3.3V Regulator		75μA	100mA
ADXL335 Acceleromete		350μA	
3.3V to Op Amp		4μA	

Power Regulation



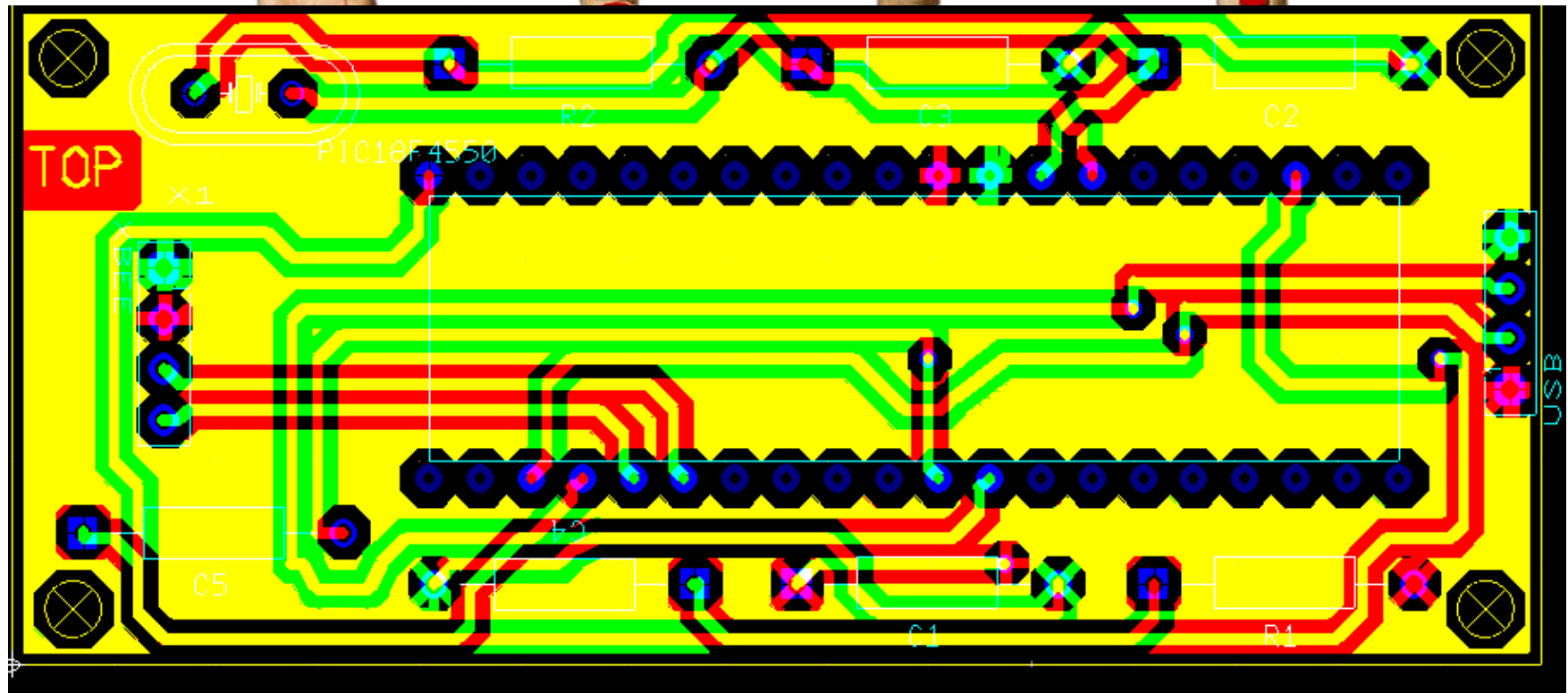
USB Device

- Uses a standard PIC18F4550 set-up with 20MHz crystal
- Requires 470nF capacitor on pin 18 to ground

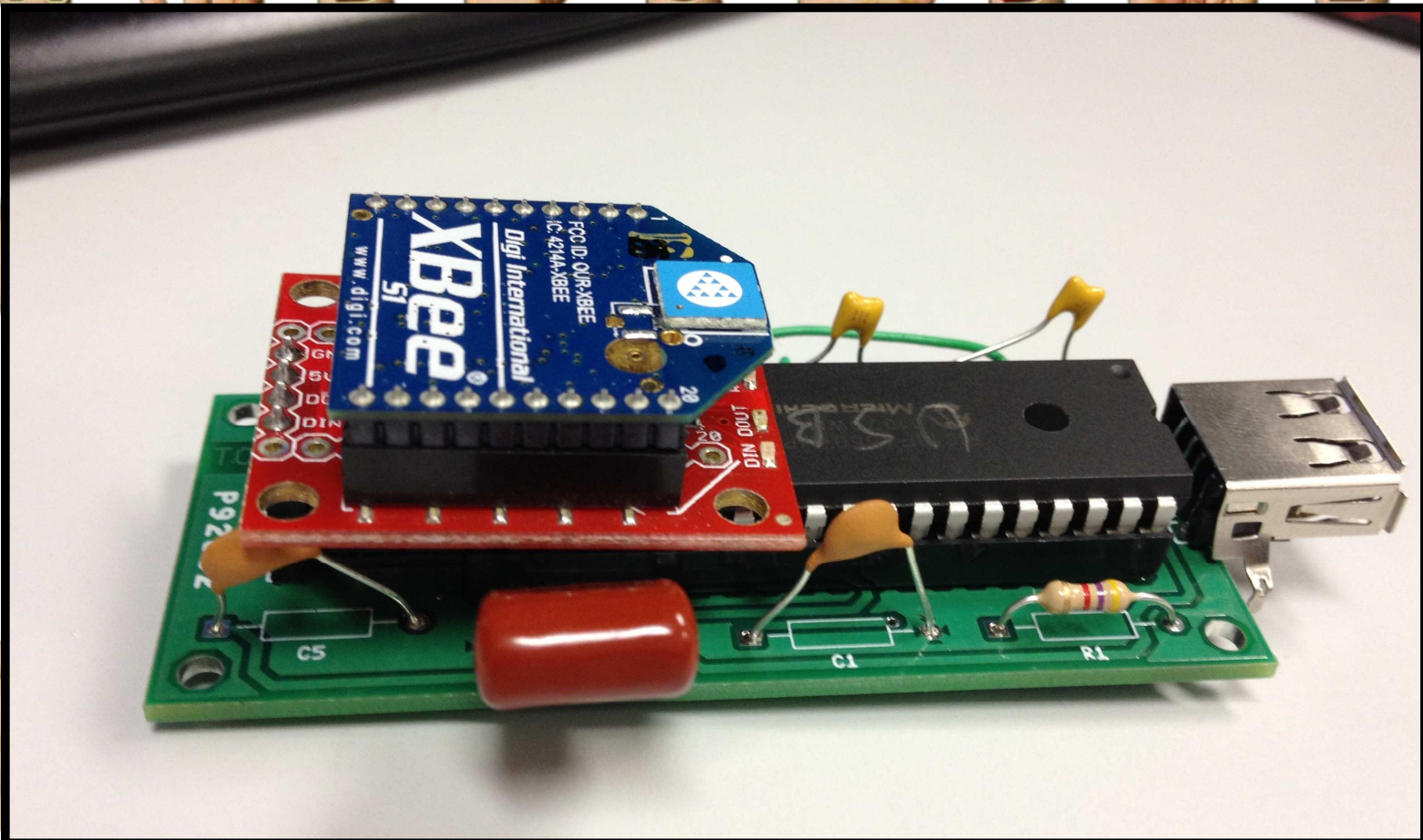




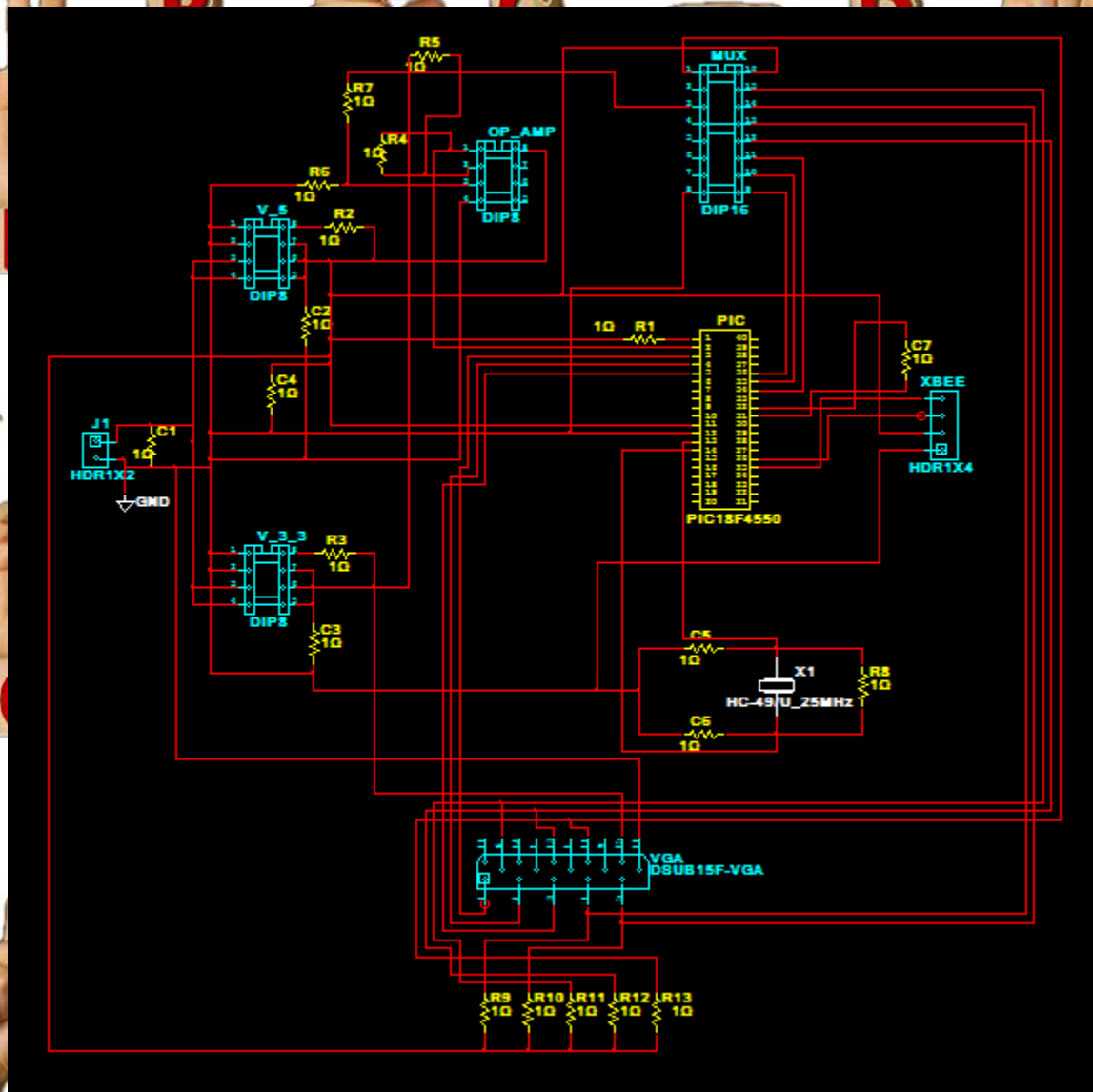
PCB – Glove Layout



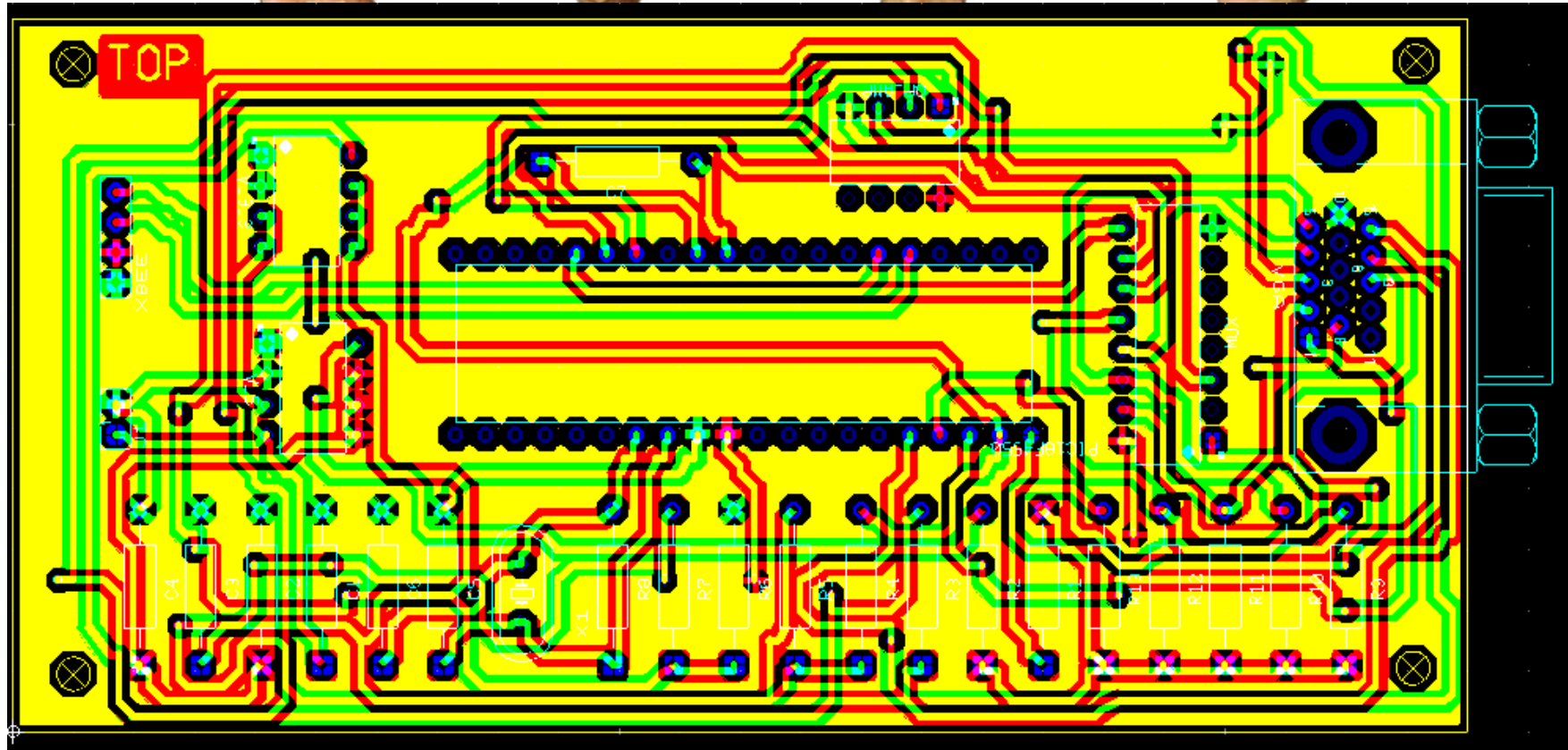
USB Device



Glove Circuit



PCB – Glove Layout



Software Design

- Analog to Digital Conversion
- Letter Determination
- Letter Wireless Output
- USB Device



Analog to Digital Conversion

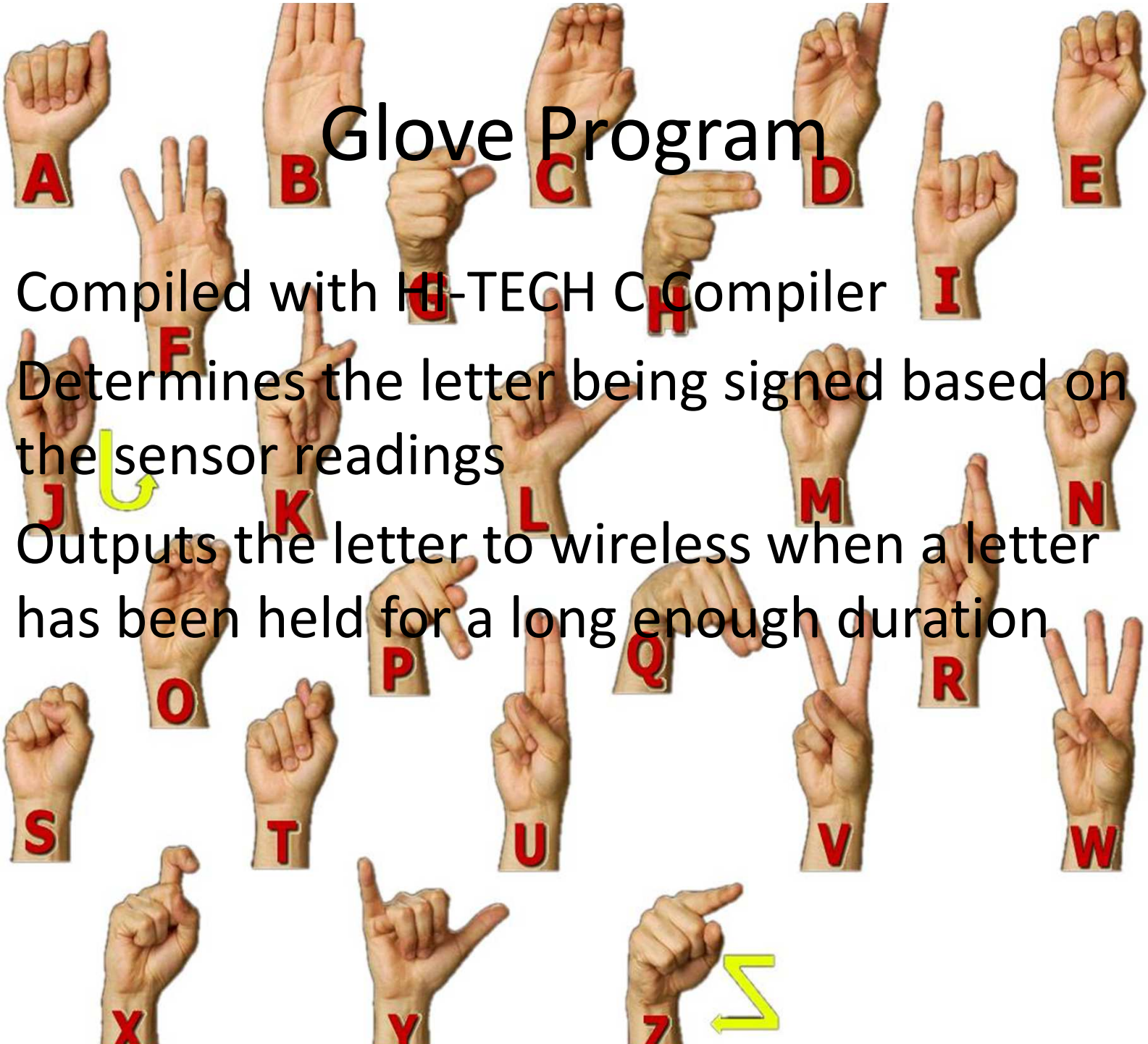
- 10 bit Analog to digital
— 0-1023

Sensor Voltage Values

	Min Voltage	Max Voltage	Min A2D	Max A2D
Thumb	0.635	5.05	130	1023
Index	2.445	4.42	501	905
Middle	0.76	5.1	156	1023
Ring	0.825	4.24	169	868
Pinky	1.68	4.94	344	1012
Accelerometer	1.05	2.03	215	416

Glove Program

- Compiled with HI-TECH C Compiler
- Determines the letter being signed based on the sensor readings
- Outputs the letter to wireless when a letter has been held for a long enough duration



Glove Program



Glove Program

- Letter Determination Function
 - Evaluates the 5 flex sensors and the X output of the accelerometer based on preset values
 - If all 6 values match the presets, the enumeration of the letter or symbol is returned
 - A-Z = 1-26
 - Delete = 27
 - BISON = 28
 - Null = 0

Glove Program Variables

- Determined Letter
 - Output from the Letter Determination Function
- Output Letter
 - The last letter sent to wireless
- Previous Letter
 - The output from the Letter Determination Function from the previous loop
- Repeat Letter Counter
 - Increments when the newly Determined Letter is the same as the Previous Letter
- Reset for New Letter Counter
 - Increments when the newly Determined Letter does not equal the last Output Letter
- Successful Letter Signed Flag
 - Set when a letter has just been output to wireless

Glove Program Variables

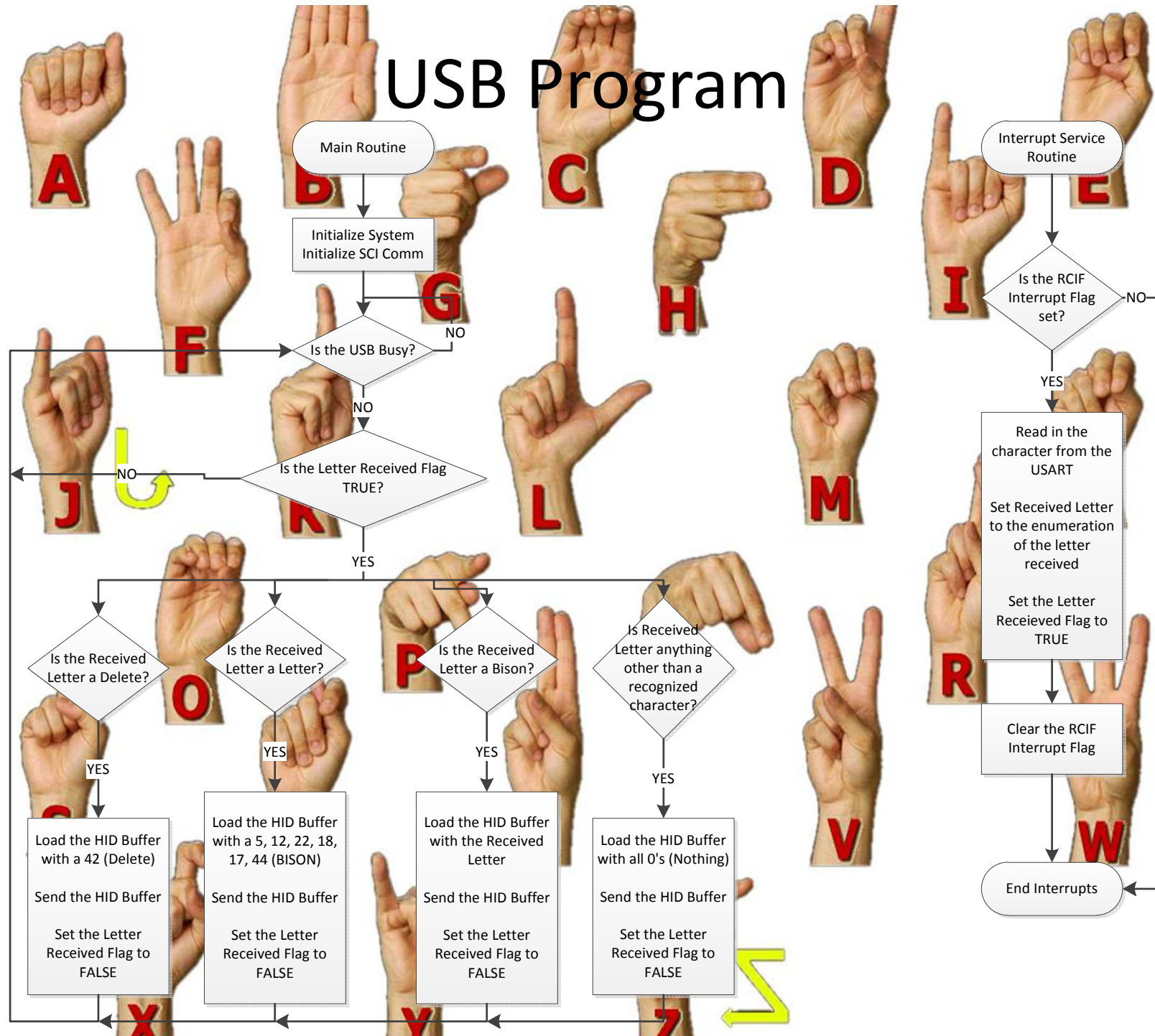
- Reset for New Letter Counter
 - Increments when the newly Determined Letter does not equal the last Output Letter
- Successful Letter Signed Flag
 - Set when a letter has just been output to wireless



USB Program

- Compiled using Microchip C18 Compiler
- Reads in the sent letter from the glove module
- Outputs the corresponding letter to the PC using USB
- Acts as a keyboard, so it is compatible with any program that accepts text

USB Program



USB Program

- HID Buffer

- Sends out up to 6 characters, based on preset enumeration

- A-Z = 4-29

- Delete = 42

- For all except delete, a space is added to separate the letters

- Space = 44

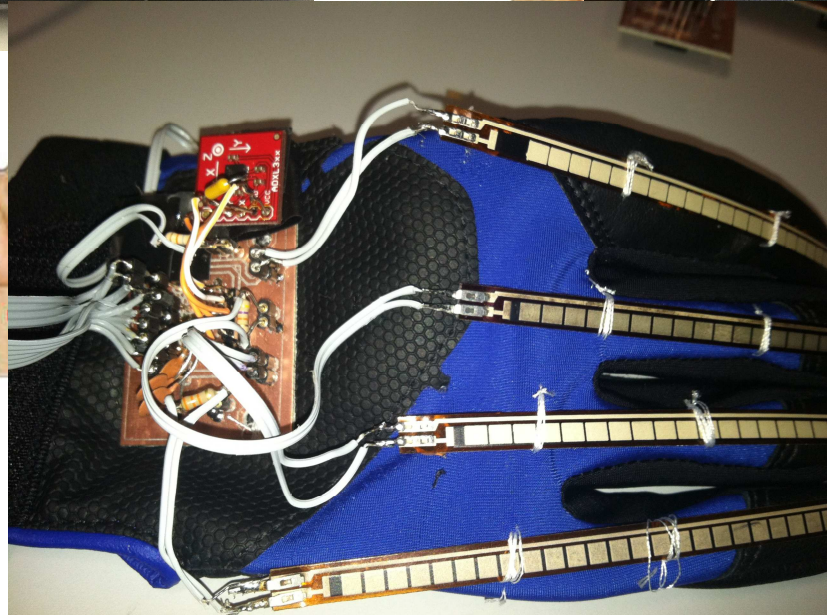
Testing and Evaluation

- Always plug the USB Receiver in first
 - Xbees are programmed to avoid all interference from similar devices
- On glove power-up, “bison” is printed to the screen, and then deleted away
- The Xbee breakout boards light up if powered up properly

Testing and Evaluation

- The final glove recognizes symbols fairly accurately
 - The sample time is currently uncontrolled and is too fast
 - Some letters get output in the process of moving the hand to a different letter
 - C, E, O
 - Some letters are very difficult to get output due to similarity
 - R, U, V
 - The delete function is useful and works well
- USB device successfully receives and outputs letters sent by the glove

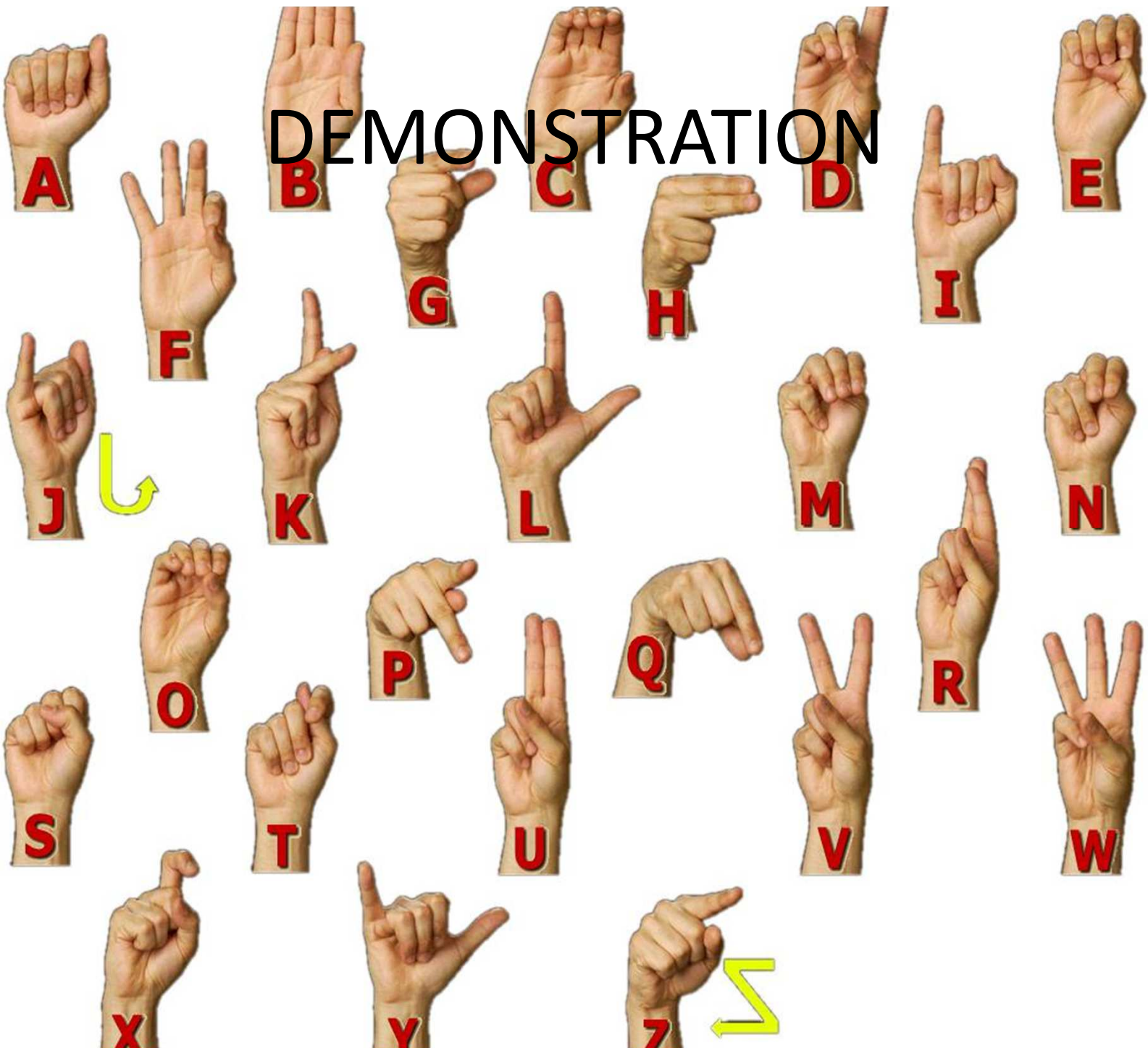
Final Product



Final Product



DEMONSTRATION



Obstacles

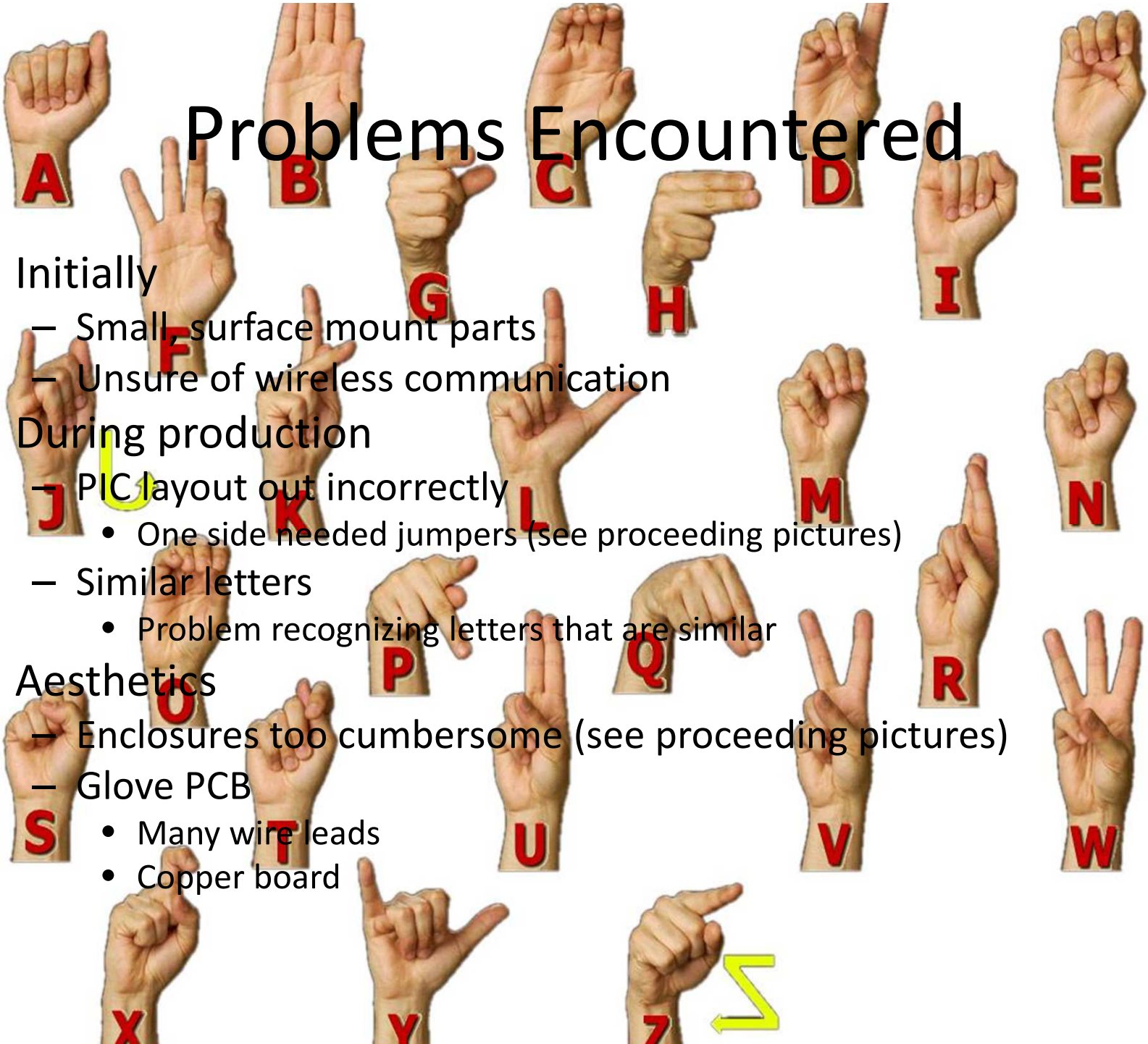
- Get familiar with American sign language
- Understanding components (such as accelerometer) and compatibilities
- Learning how wireless transmitters and receivers send and receive data
- Finding ways different technologies interface together in one system
- Creating code that can interpret many sensors at once

Obstacles

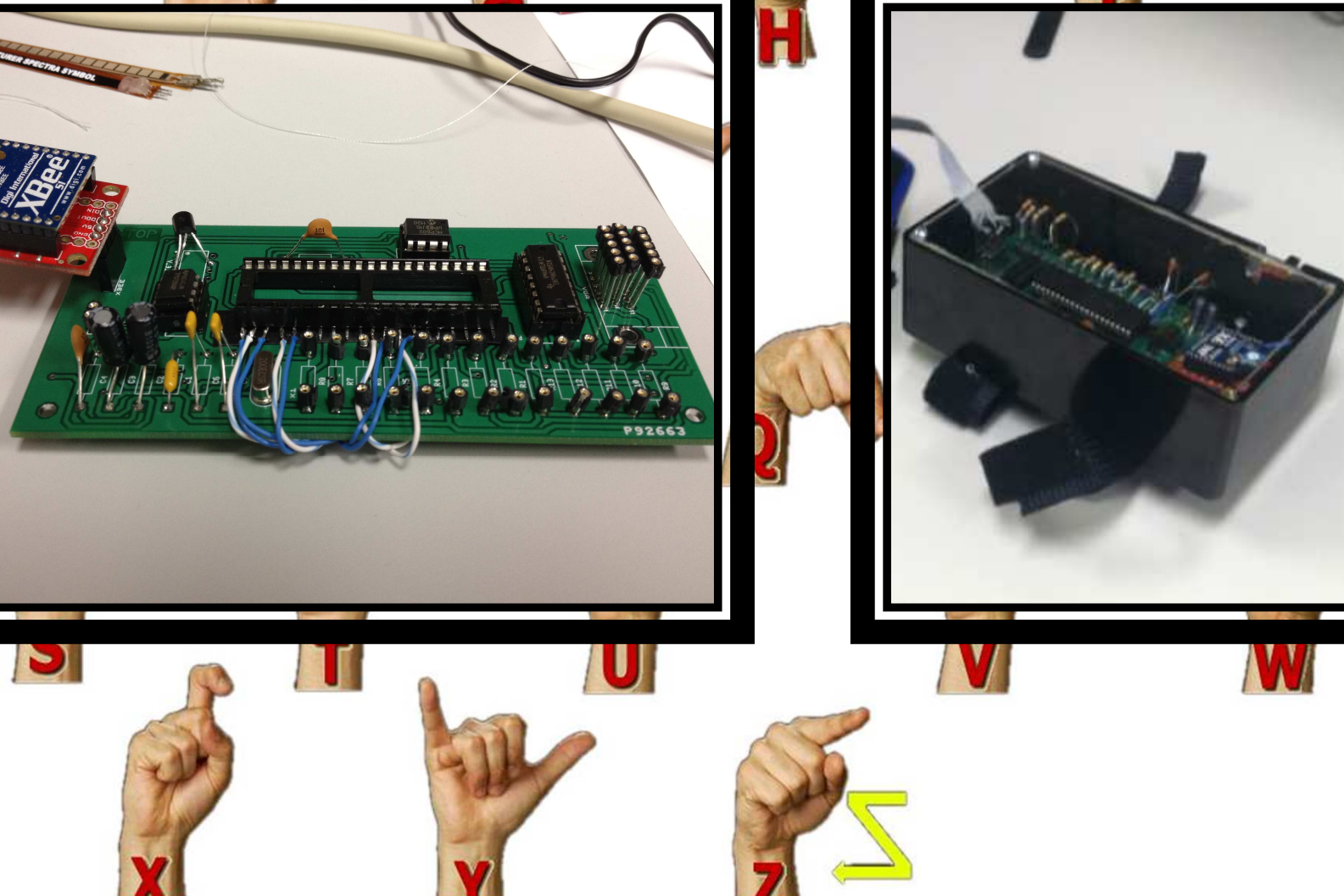
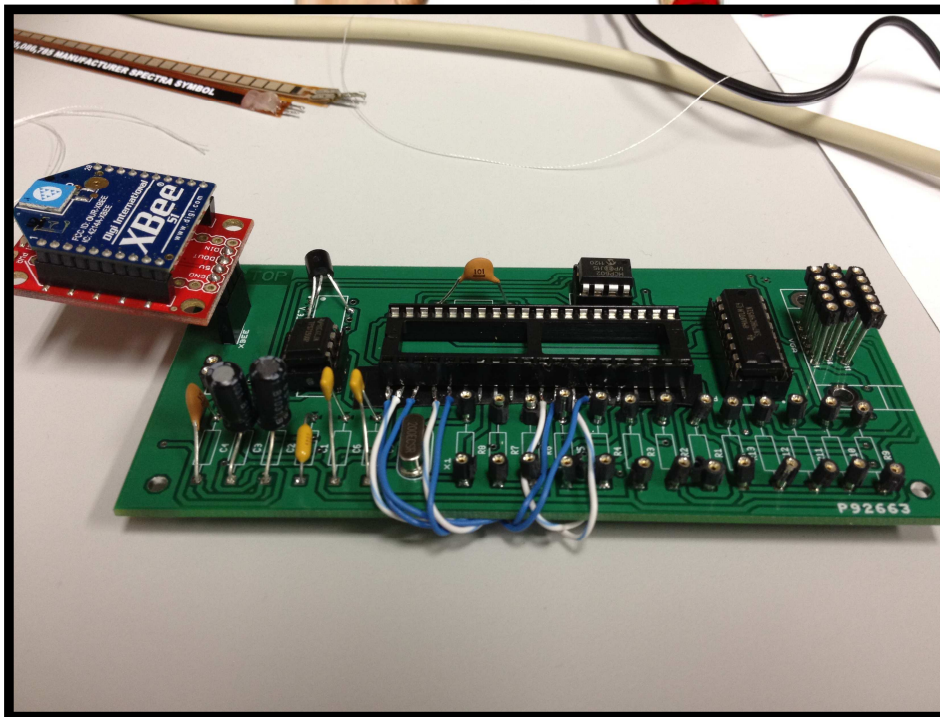
- Flex sensors vary in resistance greatly and are prone to failure
- Creation of Ultiboard parts
- Limited use of debugging indicators until late

Problems Encountered

- Initially
 - Small surface mount parts
 - Unsure of wireless communication
- During production
 - PIC layout out incorrectly
 - One side needed jumpers (see proceeding pictures)
 - Similar letters
 - Problem recognizing letters that are similar
- Aesthetics
 - Enclosures too cumbersome (see proceeding pictures)
 - Glove PCB
 - Many wire leads
 - Copper board

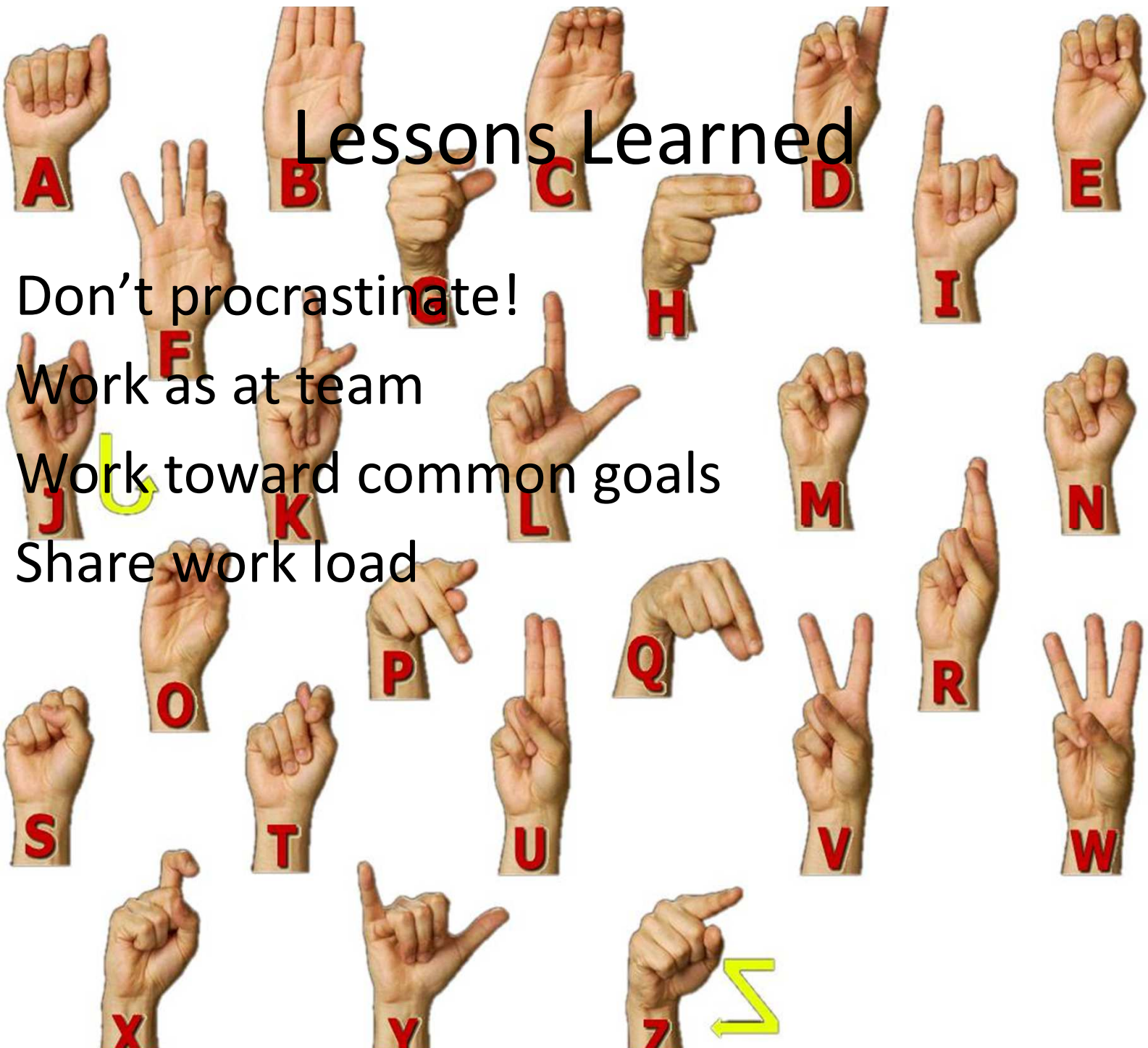


Problems



Lessons Learned

- Don't procrastinate!
- Work as at team
- Work toward common goals
- Share work load



Full Budget

Project Expenditures (Spring 2011)

Date of Invoice	Quantity	Item	Unit Price	Amount
3/14/2011	3	IC DUAL USB PORT	\$1.33	\$3.99
3/14/2011	2	IC LDO REG ADJ	\$2.64	\$5.28
3/14/2011	2	IC CONV SERIAL-TO-USB	\$6.75	\$13.50
3/14/2011	2	IC MCU 16BIT 8K FLASH 3	\$4.95	\$9.90
3/14/2011	2	IC RF TXRX SNGL-CHIP	\$4.20	\$8.40
3/28/2011	4	IC PIC MCU FLASH 16KX16	\$6.80	\$27.20
3/28/2011	2	IC EEPROM 2KBIT	\$0.50	\$1.00
3/28/2011	2	IC MCU 16BIT 32K FLASH	\$17.27	\$34.54
4/5/2011	2	MODULE 802.15.4 1MW W/CHIP ANT	\$19.00	\$38.00
5/3/2011	2	MODULE 802.15.4 1MW W/CHIP ANT	\$19.00	\$38.00
5/16/2011	5	PIC18F4550	\$4.00	\$20.00
6/6/2011	6	FLEX RESISTORS	\$12.50	\$75.00
10/21/2011	2	OP AMP	\$1.50	\$3.00
11/8/2011	2	VOLTAGE REGULATOR 5 VOLT	\$2.75	\$5.50
11/8/2011	2	VOLTAGE REGULATOR 3 VOLT	\$2.75	\$5.50
11/8/2011	1	MULTIPLEXER	\$3.50	\$3.50
11/12/2011	2	PROFESSIONAL PCB	\$53.00	\$106.00
Sub Total =				\$398.31

Budget for Glove

Glove Expense			
Quantity	Item	Unit Price	Amount
1	GLOVE	\$19.00	\$19.00
2	PIC18F4550	\$4.00	\$8.00
5	FLEX RESISTORS	\$12.50	\$62.50
1	OP AMP	\$1.50	\$1.50
1	VOLTAGE REGULATOR 5 VOLT	\$2.75	\$2.75
1	VOLTAGE REGULATOR 3 VOLT	\$2.75	\$2.75
1	MULTIPLEXER	\$3.50	\$3.50
2	PROFESSIONAL PCB	\$53.00	\$106.00
XX	MISC. (RESISTORS, CAPS, CRYSTALS)	\$19.00	\$19.00
Total =			\$225.00

Future Work

- Better flex sensors
- Recognizing similar letters
 - Touch sensors
- Implanting wires into glove
- Improve timing of letter determination
 - Currently untimed procedure
- Reducing the size of the forearm box
 - All PIC's could have been 20-pin

Future Projects

- Dual glove to cover all American Sign Language
- A hand operated gaming controller
- Gesture mouse for PC
- Remote control for devices/robots



Summary

- Team work helped us complete:
 - Deadlines
 - Obstacles
- Split tasks appropriately for areas of expertise, work efficiently, shared burdens
- Pulled together in crunch time to finish project on time and working!

